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DRIVING METHOD FOR DISPLAY PANEL AND DISPLAY DEVICE

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Specification

1. Title of the Invention:

DRIVING METHOD FOR DISPLAY PANEL AND DISPLAY DEVICE

2. Scope of Claim for Patent

(1) A driving method for a display panel, wherein desired display is performed by using a partial scan mode in which a predetermined voltage is applied only to a pixel required to be rewritten to renew display in combination with a full scan mode in which the display panel is entirely scanned and a predetermined voltage is applied to renew display only when rewrite is required, in the matrix display panel in which optical characteristics show bistability against an applied electric field.

(2) The driving method for a display panel according to Claim 1, wherein the matrix display panel uses ferroelectric liquid crystal.

(3) A display device comprising:

a matrix display panel in which optical characteristics show bistability against an applied electric field;

a partial scan control means which renews display by scanning only a scanning electrode required to be rewritten;

a full scan control means which renews display by entirely scanning the display panel only when rewrite is required; and

a selection means which switches the partial scan control means and the full scan control means,

wherein the display panel is driven by switching the partial scan control means and the full scan control means in accordance with a predetermined rule.

(4) The display device according to Claim 3, wherein the display panel is driven by the full scan control means every time the display panel is driven predetermined times by the partial scan control means.

(5) The display device according to Claim 3 or 4, wherein the matrix display panel uses ferroelectric liquid crystal.

(6) A display device comprising:

a matrix display panel in which optical characteristics show bistability against an applied electric field;

a partial scan control means which renews display by scanning only a scanning electrode required to be rewritten;

a full renewal control means which renews display by entirely scanning a display panel; and

a selection means which switches the partial scan control means and the full renewal control means,

wherein the display panel is driven by the full renewal control means at predetermined time intervals.

(7) The display device according to Claim 6, wherein the matrix display panel uses ferroelectric liquid crystal.

3. Detailed Description of the Invention

Field of Industrial Application

The present invention relates to a driving method for a display panel having a memory property in itself and to a display device.

Prior Art

Recently, demand for a large-area thin display device has been increasing in the field of computers and other information equipment. As this kind of a display device, a liquid crystal display device having a characteristic of low power consumption is being widely used. Specifically, a ferroelectric liquid crystal panel has a characteristic that visual quality is not decreased even when the number of scanning lines is increased since the ferroelectric liquid crystal panel has a memory property in itself. Thus, the ferroelectric liquid crystal panel is expected to be put into practical use.

A conventional driving method for a display panel using a ferroelectric liquid crystal panel is hereinafter described with reference to the drawings.

FIG. 5 is a schematic diagram showing an electrode of a matrix panel, which shows an example of a dot matrix panel of m rows by n columns. In FIG. 5, C1, C2,

C3, C4, ..., and Cn denote signal electrodes, R1, R2, R3, R4, ..., and Rm denote scanning electrodes, and an intersection of the signal electrode and the scanning electrode is a pixel.

FIG. 6 is a scan sequence diagram showing a conventional driving method for a display panel using a ferroelectric liquid crystal panel. R1, R2, ..., and Rm of a vertical axis denote scanning electrodes and a horizontal axis is a time scale. In FIG. 6, Tr denotes a reset period and Ts denotes a write period. In the reset period Tr, a pixel is put into a first or second stable state, and in the write period Ts, whether the stable state is inverted or preserved is determined in accordance with image data and the image data is written in the pixel. In the case of this example, pixels corresponding to eight scanning electrodes are simultaneously reset in the reset period Tr; subsequently, the scanning electrodes are scanned one by one in the period Ts to write in image data. Thereafter, similar processes are repeated to scan all scanning electrodes, thereby completing one screen (for example, described in Japanese Patent Laid-Open No. S62-175714, "OPERATION METHOD FOR MATRIX FERROELECTRIC LIQUID CRYSTAL PANEL").

Problems to be Solved by the Invention

However, in the above-described driving method, time Tf for rewriting one screen is expressed as follows.

$$Tf = (m/8)\cdot Tr + m\cdot Ts$$

(Note that m is a multiple of 8.)

In order to shorten the time Tf for rewriting one screen, the reset period Tr needs to be made as equal to the write period Ts as possible. However, when the reset period Tr was shortened, there was a problem of deteriorating liquid crystal bistability and accordingly reducing display contrast.

Since scanning lines were simultaneously reset block by block (in this case, eight lines), there was also a problem of generating variation in display luminance with a cycle of the block.

The invention solves the above problems and provides a driving method for a

display panel and a display device which enable high-quality display.

Means to Solve the Problem

In order to solve the above-described problems, a driving method for a display panel and a display device of the invention use a partial scan mode in which a predetermined voltage is applied only to a pixel required to be rewritten to rewrite display in combination with a full scan mode in which the display panel is entirely scanned to renew display only when rewrite is required, with the use of a bistable matrix display panel as the display panel.

In addition, full renewal driving in which a display panel is entirely scanned to renew display regardless of necessity for rewrite is performed at predetermined time intervals.

Further, a ferroelectric liquid crystal display panel is used as the display panel.

Operation

Operation according to the technical means is as follows.

In the invention, average screen renewal time can be drastically shortened since only a pixel required to be rewritten is scanned to renew display with the use of a bistable display panel. Further, display uniformity can be maintained even when a screen renewal portion according to the partial scan mode is partial, since display is renewed also by the full scan mode if necessary.

Even when there is no necessity for rewriting display, a screen is forcibly renewed and display stability can be improved by performing full renewal driving if necessary.

In addition, a display panel which has stable bistability and which can perform high speed operation can be easily realized by using a ferroelectric liquid crystal display panel as the display panel.

Embodiment

A driving method for a display panel and a display device of one embodiment

of the invention are hereinafter described with reference to the drawings.

FIG. 1 is a scan sequence diagram showing a driving method for a display panel of one embodiment of the invention. In FIG. 1(a), R1, R2, ..., and Rm of a vertical axis denote scanning electrodes and a horizontal axis is a time scale. Ts denotes a display renewal period, during which each scanning electrode is rewritten. FIG. 1(b) shows timing of demand for rewriting display, in which a high level is reached when rewrite is required. FIG. 1(c) shows a scan mode and a state of switching between the partial scan mode and the full scan mode.

As is apparent from FIG. 1, in the partial scan mode, a necessary scanning electrode is scanned and display is renewed only when rewrite is required. On the contrary, in the full renewal mode, all scanning electrodes are scanned toward a demand for rewrite, and display is entirely renewed.

Screen renewal time can be drastically shortened and display uniformity can be maintained by normally driving the display panel with the partial scan mode and occasionally driving with the full scan mode.

FIG. 2 is a block diagram showing a general structure of a display device of one embodiment of the invention. Reference numeral 20 denotes a memory for storing display data; 21, a mode switching circuit for selecting a partial scan or a full scan; 22, a memory control circuit for controlling the memory; 23, a comparator circuit for extracting renewal data in the case of a partial scan; 24, a data control circuit for controlling data to be rewritten; 26 and 27, a scan driver and a signal driver for driving a display panel 28; 29, a drive voltage source for generating a drive voltage; and 30, a generation circuit of a scan mode switching signal.

As to the display device of the invention having the above-described structure, operation thereof is described hereinafter.

Display data generated in a CPU or the like is stored in the data memory 20, and in accordance with a display mode, renewal data is extracted by the comparator circuit 23 in the case of the partial scan. Data necessary for the data control circuit 24 is read out of the memory. The memory control circuit 22 controls write and read of the data memory 20, while the driver control circuit 25 controls the scan driver 26 and

the signal driver 27 in synchronization with timing of read and scans only a scanning electrode required to be rewritten. Meanwhile, in the case where a display mode is the full scan, the data in the data memory 20 is sequentially read out and the display panel 28 is entirely scanned to renew a screen.

FIG. 3 is a block diagram showing another structure of a mode switching signal generation circuit in a display device of another embodiment of the invention. Reference numeral 30a denotes a counter, which counts the number of rewrite request signals generated based on the result of the comparator circuit 23. When the number of rewrite request signals reaches a preset number, the counter outputs a scan mode switching signal. By employing such a structure, the full scan can be performed when the partial scan is performed several times. Thus, highly uniform display can always be maintained.

In addition, a structure of the mode switching signal generation circuit may be a timer as denoted by reference numeral 30b, and a predetermined clock signal may be inputted thereto to output the scan mode switching signal at regular time intervals. By employing such a structure, the full scan is regularly performed even in the case where rewrite seldom occurs in the partial scan mode. Thus, highly uniform display can always be maintained.

It goes without saying that both structures of the counter 30a and the timer 30b may be used in combination as the structure of the mode switching signal generation circuit.

FIG. 4 is a voltage waveform diagram in the case of using ferroelectric liquid crystal as an example of a driving method for a display panel and a waveform of a drive voltage for rewriting a pixel over one scanning electrode of a display device of one embodiment of the invention and a graph showing optical response of the pixel. FIG. 4(a) shows a drive voltage of a pixel to be rewritten. Reference numeral 41 denotes a write voltage waveform for OFF; 42, a write voltage waveform for ON; and 43, a bias voltage waveform in the case of scanning an adjacent scanning electrode. $\pm Vs$ is a voltage which inverts a bistable state of liquid crystal; $\pm Vn$, a voltage which does not invert a bistable state; and $\pm Vb$, a bias voltage. As to ferroelectric liquid crystal,

ON/OFF is determined depending on polarity of final ±Vs. Therefore, optical transmittance turns to Boff according to the write waveform 41 as shown in FIG. 4(b). The state is maintained with a bias voltage and without voltage application. On the contrary, transmittance turns to Bon at the write voltage 42 according to final +Vs. Thus, desired display can be performed by applying a predetermined voltage only to a pixel required to be rewritten.

Note that the drive voltage waveform shown in FIG. 4 is only one line, and the invention is not limited thereto.

Effect of the Invention

As described above, the invention uses a partial scan mode in combination with a full scan mode. Therefore, all scanning electrodes are scanned by a full scan even when a partial scan portion is partial. Thus, highly uniform display can always be maintained.

In addition, effective screen renewal time can be drastically reduced and high display uniformity can be maintained by performing full scan driving every time partial scan driving is performed predetermined times. Further, display uniformity can be maintained without depending on a display rewrite state by normally driving with partial scan and regularly driving with full scan at predetermined time intervals.

In partial scan driving, scanning is performed only when rewrite is required. Therefore, a driver circuit of a display device can be stopped while having no change in display contents. Thus, also a ripple effect in which power consumption is reduced can be obtained.

4. Brief Description of Drawing

FIG. 1 is a scan sequence diagram showing a driving method for a display panel of one embodiment of the invention; FIG. 2 is a block diagram showing a general structure of a display device of one embodiment of the invention; FIG. 3 is a block diagram showing another structure of a mode switching signal generation circuit in a display device of another embodiment of the invention; FIG. 4 is a graph showing a

driving method for a display panel of one embodiment of the invention and a waveform diagram of a drive voltage for rewriting a pixel over one scanning electrode of a display device and optical response of the pixel; FIG. 5 is a schematic diagram showing an electrode of a matrix panel; and FIG. 6 is a scan sequence diagram showing a conventional driving method for a display panel using a ferroelectric liquid crystal panel.

Ts: Write period, 20: Data memory, 21: Scan mode switching circuit, 22: Memory control circuit, 23: Comparator circuit, 24: Data control circuit, 25: Driver control circuit, 26: Scan driver, 27: Signal driver, 28: Display panel, 29: drive voltage source, 30: Mode switching signal generation circuit, 30a: Counter, 30b: Timer, 41: Write voltage waveform for OFF, 42: Write voltage waveform for ON, 43: Bias voltage, R1, R2, ..., and Rm: Scanning electrode, and C1, C2, ..., and Cn: Signal electrode.

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